STANDARDS AND LABELLING OF SOLAR PHOTOVOLTAIC (PV) PANELS

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BACKGROUND FOR STANDARDS AND LABELING

India has embarked upon an ambitious program to achieve 40% of electric power installed capacity from non-fossil fuel by 2030 to meet its Nationally Determined Commitments & has initiated one of the largest Renewable Capacity expansion program in the world which includes about 100 GW of Solar Energy. Therefore, Renewable Energy (RE) sector is bound to see exponential growth over the next decade.

As more and more users embrace renewable energy technologies (e.g. Solar PV and Solar Water heaters) optimizing the performance of this RE equipment becomes necessary. Absence of a regulation or performance standard for Solar PV & Solar Water heaters has resulted as a challenge to consumers in making an informed choice while purchasing this equipment. Also, there is an absence of a level playing field in terms of quality products against the cost-competitive substandard ones being sold in the market causing the markets to be flooded with poor quality low-cost Solar PV panels & Solar Water heaters.

Accordingly, BEE proposes to introduce standards and labelling (S&L) program for Solar PV panels and Solar Water Heaters. Proliferating energy efficiency through Standards & Labeling is cost-effective as energy savings from such initiative are generally assured, and comparatively simple to quantify, and readily verify able.

TECHNICAL COMMITTEE MEETING 15TH APRIL 2019: CONCERNS IN SOLAR PV STAR LABELLING SCHEDULE

In the technical committee, meeting manufacturers mentioned that combining both the thermal coefficient of power (δ) and efficiency (η) for different types (especially the technology) of Solar PV panels cells in a single performance rating matrix may not be the technically correct way of rating a PV panel(Table 1).

Table 1 Last proposed star rating table for Solar PV panel

	1 Star	**2 Star**	**3 Star**	**4 Star**	**5 Star**
Module Efficiency %	≥12	≥15	≥18	≥21	≥24
Temperature coefficient for power (δ) (% / °C)	≥ -0.45	≥ -0.4	≥ -0.35	≥ -0.28	≥ -0.25

However, all agreed that the performance of Solar PV panel reduces with at higher temperatures. Therefore, it is essential to consider the variation in performance due to temperature effects. In addition, it was recommended to refer IS 16170 part1: 2014 as for revising the rating methodology.

PROPOSED STAR RATING METHODOLOGY FOR SOLAR PV

As proposed/decided in the TCM '*IS 16170 part1:2015 Photovoltaic (PV) Module Performance Testing and Energy Rating; Irradiance and Temperature Performance Measurements and Power*

Rating' is followed to devise the new rating methodology. This part of IS 16170 describes the requirements for evaluating PV module performance in terms of power rating over a **range of irradiances and temperatures**.

WEATHER ANALYSIS FOR ADOPTING IS16170 PART1: 2014

The object of S&L for solar PV panels is to help the **Indian customers** to make an informed decision and contribute towards the **Government of India's larger goal** of reducing the CO_2 emission. Hence it is of prime importance to analyse the climatic condition of India across five climatic zones.

Weather data of thirty-three cities across five climatic zones of India was analysed to determine the number of hours across different temperature (ambient/Dry Bulb Temperature) ranges. Table 2 tabulates the percentage of the total sunshine hours in different temperature ranges. The percentage of hours are used as weights for determining the effective efficiency(η_{eff}) of the module.

Table 2 percentage of total sunshine hours across the different temperature range

Ambient temperature (˚C)	% of sunshine hours
0-25	14
25-35	62
>35	24

The relation between ambient temperature and module temperature is given by equation 1. Where NOCT (Nominal Operating Cell Temperature) is taken as 45℃ and G (insolation on PV array) is assumed to be $800 Wm^{-2}$. After equating the values for Insolation(G) and NOCT the relation between the module temperature T_{module} and ambient temperature T_{amb} is given by equation 2. From equation 2 it can be concluded that the module temperature shall be 25℃ greater than the ambient temperature.

$$T_{module} = T_{amb} + \frac{NOCT - 20}{800} \times G \quad \ldots\ldots \quad \text{Equation 1}$$

$$T_{module} = T_{amb} + 25 \quad \ldots\ldots \quad \text{Equation 2}$$

STAR LABELLING METHODOLOGY

As per part 1 of IS 16170, it is required to find the power rating of the PV module over a range of irradiances and temperatures. The matrix as per Table 3 needs to be filled for each of the

parameters like short circuit current (I_{sc}), open circuit voltage(V_{oc}), maximum voltage (V_{max}), and maximum power (P_{max}).

Table 3 P_{max} versus irradiance and temperature

Irradiance (Wm^{-2})	**Module temperature**		
	25℃	50℃	75℃
1100			
1000	$P_{max,25℃}$	$P_{max,50℃}$	$P_{max,75℃}$
800			
600			
400			
200			
100			

CALCULATING THE MAXIMUM EFFICIENCY AT DIFFERENT TEMPERATURES AT 1000 Wm^{-2}

Similarly, for star labelling, it is required to calculate/determine the maximum efficiency η_{max} of the module just for an irradiance value of 1000 Wm^{-2} at different temperatures[1]. The efficiency of the module is determined by equation 3 for all the temperatures mentioned in Table 3.

$$\eta_{max,t℃} = \frac{P_{max,t℃}}{I \times A} \times 100 \quad \ldots\ldots \quad \text{Equation 3}$$

EFFECTIVE EFFICIENCY (η_{eff})

The effective efficiency is given by equation 4. The effective efficiency is derived in such a way that it helps to rate the performance of the PV panel based on both efficiencies as well as thermal performance. The weights (0.14, 0.62 & 0.24) in equation 4 are representative of the percentage of total sunshine hours a PV panel shall be exposed to the respective temperature. The weights are determined by analysing the weather data of thirty-three Indian Cities across five climatic zones.

[1] The 1000 Wm^{-2} is just a recommendation for the committee members to begin with discussion. The testing parameters will be finalized based on the outcome of TCM.

$$\eta_{eff} = (0.14 \times \eta_{max,25°C}) + (0.62 \times \eta_{max,50°C}) + (0.24 \times \eta_{max,75°C}) \quad \ldots\ldots \quad \text{Equation 4}$$

Finally, the rating of the solar PV panel will be based on the effective efficiency (η_{eff}) of the panel.

Table 4 Star rating table for Solar PV panels

	1 Star	2 Star	3 Star	4 Star	5 Star
% $\eta_{eff.}$	≥11.5	≥13	≥14.5	≥16	≥17.5

STAR RATING TABLE AND ITS BACKGROUND

The efficiency ranges for star rating are decided based on the analysis of more than two hundred PV panels across from thirteen PV panel manufacturers. Currently, 60% of the PV panels are spread across 3-star and 4-star ratings (see Table 5).

Table 5Percentage of PV panel models across different efficiency ranges

Star rating	Effective Efficiency ranges	Percentage of PV panel models
	<11.5	13%
1 star	≥11.5	8%
2 stars	≥13	13%
3 stars	≥14.5	30%
4 stars	≥16	32%
5 stars	≥17.5	5%

PREREQUISITES FOR STANDARDS AND LABELLING SCHEME APPLICATION

Solar PV panels are covered under CRS(Compulsory Registration Scheme). Ministry of Electronics & Information Technology (MeitY) has notified "Electronics and Information Technology Goods (Requirement for Compulsory Registration) Order on 3rd Oct 2012. The Order since then, is progressively being applied to increasing product categories of Electronic Goods.

From January 2019 the Solar PV panels are included in CRS(Compulsory Registration Scheme).It is mandatory for all the Solar PV panel manufacturers to comply with IS14286 for crystalline PV modules and IS16077 for thin-film PV modules

Hence, it is mandatory for the Solar PV Panel manufacturer to hold the valid registration under CRS while applying for Standards and Labeling scheme.

DOCUMENTS TO BE SUBMITTED

The manufacturer needs to submit proof of CRS registration and the test report mentioning the details listed in Table 6for award of BEE star label

Table 6 Details to be submitted for award of star label

Laboratory name		
Address		
Date of receipt		
Test report No.		
Tested by		
Date of testing		
Reviewed by		
Brand name		
Model name / number		
Serial number		
Year of manufacture		
Nameplate capacity of the PV panel		
Power output (when tested as per clause 8 of IS 16170 part1:2015)	At STC	
	At 50°C	
	At 75°C	
Effective Efficiency $(\% \boldsymbol{\eta}_{eff.})$.		